

SPECIES BIOLOGY, THE KEY TO PLANT PRESERVATION

J. R. MASSEY AND PAUL D. WHITSON

The enactment of the Endangered Species Act has resulted in the initiation of a number of programs and activities to increase our understanding of rare and endangered species and to promote their preservation. We see, in response to the Act, three types of information being generated: (1) general information mostly associated with list preparation and evaluation; (2) population, habitat, and threat inventories, and species status reports, mostly involved in legal listing and delisting activities; and (3) specialty area oriented studies such as population ecology, reproductive biology, and germination ecology. All such information and studies are of value, but they often give a narrow and disjointed view of a species and its populations.

An overview of our approach to collecting information on endangered species is presented in Table 1. We feel that the four-unit program is a logical progression of activities which result in intermediate products that may be used as the various steps or units are completed. Unit I involves the retrieval of information from herbaria, libraries, and individuals. Completion of this unit requires that we summarize the state of our knowledge on a particular species. Unit II is essentially a population inventory which permits us to up-date, refine, and elaborate on the general information. These field data not only indicate what we have to work with, but allow us to establish priorities for protection, management, and study. The establishment of permanent field plots or sample areas for monitoring purposes should be an integral part of the population inventory. Unit III (Species Biology) requires that we assess at a particular level the biological status of a species at a point in time and recognize important environmental factors. Unit IV involves experimental studies of factors. This unit should be completed when factor identification and analysis seem warranted for species preservation through drastic habitat manipulation.

SPECIES BIOLOGY

Species biology, the third unit of our program, is one of the major topics of this symposium on Rare and Endangered Plants in New

Table I. **Overview of Species Information Program**

Unit I

Species General Information
 Species Taxonomic Status
 Species Phenology
 Species Legal Status
 Historical Distribution
 Habitat Preference
 Habitat Development Status

Unit II

Species Population, Habitat, and Threat Inventory Status Information
 Locality Reconnaissance
 Authentication of Species
 Precise Population Location
 Land Inventory
 Population Inventory
 Habitat Inventory
 Threat Inventory
 Author Inventory

Unit III

Species Biology Status Information
 Reproduction Status
 Dispersion Status
 Establishment Status
 Maintenance Status

Unit IV

Environmental Factor Status Information
 Influence on Reproduction Status
 Influence on Dispersion Status
 Influence on Establishment Status
 Influence on Maintenance Status

England. The brief discussion that follows emphasizes the concepts, principles and values of species biology.

We define species biology as the study of individuals, populations, and population systems of a species utilizing the products, processes, and habitat relationships of each major life cycle phase within a particular time reference. The use of a life cycle model promotes a broad and systematic view of a species and its basic biology, yet is specific in detail and provides an excellent organiza-

tion for the formulation of basic questions, design of studies, and evaluation of results. The use of a life cycle processes and products approach to life cycle success or failure places emphasis on the basic biology of species and is based on demographic composition of the component populations. This system promotes the detection of many different relationships between life cycle phase processes and products, and the habitat of a species on an interpopulational basis. It also provides a current and sound basis for comparisons between species.

The following concepts or principles have guided the development of our program:

1. Preservation is persistence of populations or species through time with or without habitat manipulation or management.

2. Long-term preservation will often depend on an adequate understanding of the biology and the interrelationships of a species to its habitat.

3. Biological investigation of rare or endangered species should include studies of all life cycle phases on a population by population basis.

4. Life cycle success or failure as assessed by plant products and processes not only indicates how a population or species is faring at a point in time, but may be used to identify significant or limiting environmental factors and relationships.

5. Specific factor manipulation or management may often be required for species preservation.

6. Detailed species biology studies of selected species may be used to make comparisons and generalizations which will allow us to focus more rapidly our research, management strategies, and efforts on other similar species and habitat types.

To implement the Species Biology unit, we have generated a matrix of high priority questions (Table 2). Using this hierarchical matrix of questions, detailed information systems for each major life cycle phase have been developed to assist in the acquisition of information (Whitson & Massey, 1979). A summary of these information categories is presented in Table 3.

VALUES OF SPECIES BIOLOGY

Although many individuals may object to a systematized approach to the study of rare or endangered species, we feel that in the interest of time and resources, such an approach is desirable.

Table 2. **Question Matrix**
(after Whitson & Massey, 1979)

Reproduction	Dispersion	Establishment	Maintenance
Is reproduction occurring?	Are propagules present?	Are new individuals present?	Is there a range of classes?
What types of reproduction are occurring?	What types of viable propagules are present?	What are the origins of the new individuals?	What are the origins of the classes?
What breeding systems are operative?	What dispersal systems are operative?	What establishment processes are operative?	What are the %'s of each class in the population?
What pollination systems are operative?	What are the dispersal units and/or agents?	What are the spatial of establishment processes?	What are the spatial relations of the classes?
What is the reproductive capacity or status of the population?	What is the dispersal effectiveness of the population?	What is the establishment effectiveness based on origin?	What is the survivorship of each class progressing to the next class?

The major values of the Species Biology Unit are discussed below.

1. *Organization of information and information acquisition.* This unit promotes cooperation between investigators and comparability of information from studies, thereby reducing duplication of effort and saving time and resources.

2. *Identification and comparison of operative products and processes, successes and failures, and potential limiting factors of each life cycle phase.* Species biology encourages a holistic view of the species and its habitats. Population to population comparisons result in improve species status reports, an appreciation of unique habitats, a better understanding of interrelationships of population composition and other habitat factors, and a sound basis for population monitoring.

3. *Evaluation and synthesis of results to verify or formulate insights and relationships about the biology, habitat factors and their interrelationship.* Species biology studies should assist us not only in establishing priorities of limiting factors to be investigated in detail, but also in making generalizations about species clusters, population and habitat site types, plant habitat types, and reproductive strategies, which could save time and resources.

4. *Application of biological and habitat information to species preservation.* Species biology studies should give us insight into management techniques such as grazing, burning, weed control, etc., as well as an indication of the effects of land use, forms of protection, and succession patterns on specific populations and species.

SUMMARY

It is our belief that long term species preservation will require deliberate actions, not simple protection through land acquisition. These protection-management actions should be based on sound biological information on species and their habitats.

Preliminary results from several studies using this approach indicate that a preponderance of rare species are successional, that the predominant means of population persistence is by asexual reproduction, that safe sites for sexual propagules are rare, and that conditions for germination and other establishment processes often differ markedly from maintenance conditions. When one considers

Table 3. Summary of the Species Biology Information Unit

Reproduction	Establishment
Reproductive System Types	New Individual Origin
Sexual	Sexual
Asexual	Asexual
Breeding System Types	Pre-Establishment Processes
Selfing	Kind by origin
Outcrossing	Distribution
Pollination System Types	Establishment Processes
Pollination types	Origin census states
Vectors	
Reproductive Capacity	Establishment Distribution
Census by origin	Origin census states
Population census	Population census states
Reproductive Effectiveness	Establishment Effectiveness
Actual	Population percentages
Potential	Origin percentages
Dispersion	Maintenance
Diaspore System Type	Population Classes
Diaspore origin	Specific
Diaspore type	Relative
Dispersal System Type	Class Origins
Release mechanism	Sexual
Transport-vector	Asexual
Dispersal Status	Population Composition & Distribution
Dispersal unit type	Sociability of individuals
Dispersal census	Distribution census
Dispersal Effectiveness	Maintenance Effectiveness
Actual	Class survivorship
Expected	Vitality/vigor of individuals

these findings it becomes quite clear, in view of changing land use and rapid habitat destruction, that Species Biology is indeed the key to plant preservation.

ACKNOWLEDGMENTS

We would like to thank Dr. A. E. Radford, L. S. Radford, Dr. J. F. Mathews, M. Weber, Sharon Morgan, and T. A. Atkinson for sharing unpublished data, as well as thought provoking comments and criticism during the development of this program.

LITERATURE CITED

WHITSON, P. D. & J. R. MASSEY 1979. Information Systems for use in Studying the Biological Status of Threatened and Endangered Plant Populations. *In*: Morse, J. L. & M. S. Henifin (eds.). Geographical Data Organization for Rare Plant Conservation. New York Botanical Garden, Bronx, New York.

J. R. M.

Herbarium, Dept. of Botany
University of North Carolina
Chapel Hill, NC 27514

P. D. W.

Dept. of Biology
University of Northern Iowa
Cedar Falls, Iowa